The Northwestern MILLER

MILLING PRODUCTION SECTION

Particle Size Distribution in Experimentally Milled Flours From Wheat Varieties of Various Quality

By R. H. Harris and G. M. Scott

EDITOR'S NOTE: The authors of the accompanying article are members of the staff of the department of cereal technology at the North Dakota Agricultural Experiment Station, Fargo. The article is published with the approval of the director of the experiment station. The wheat which was milled in the study described here was grown at six stations in North Dakota in 1953 and 1954.

In wheat variety evaluation much stress has been laid on the properties of the milled flour, with less emphasis on the wheat characteristics directly concerned with milling behavior. Test weight, a very important grading factor, is generally included in the evaluation of a new wheat for baking quality (12). Wheat of good test weight usually yields more flour and is easier to mill than low test wheat (5). Recent developments in the plant breeding field have shown, however, that test weight is not a reliable index of general milling quality and that more information on the milling performance of new varieties is required than that furnished by test weight, or even flour yield.

The effect of growth location of wheat upon milling characteristics also needs further investigation, although it is generally recognized that environment markedly influences test weight and flour yield, (4,5,12) and that these properties vary significantly from one year to another.

Flour ash content is affected by wheat variety, and the environment under which the wheat is grown (5), but whether it is a criterion of milling quality is doubtful. From work in this laboratory, it seems that flour ash is more a constituent property of the wheat, such as is protein content, than an index of milling quality. At least, the value of the flour ash determination in evaluating wheat varieties milled in the Allis experimental mill appears to be rather minor.

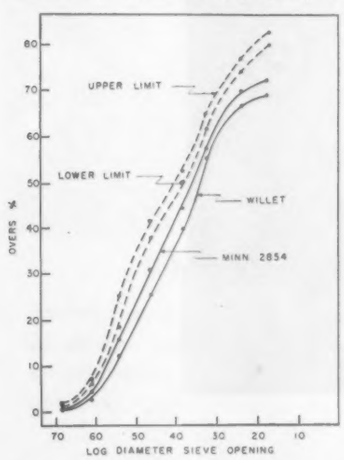

FIG. 1—Particle size distribution for nine flours milled from hard red spring wheat grown at six stations in 1954. Each dot represents six replications. Seven of the varieties fall between the broken lines.

Additional Methods Needed

Thus it appears that additional methods for assessing milling quality are needed to assist in determining the advisability of releasing new varieties for farm growth. This led the authors to search for a new technique which might aid in evaluating the milling characteristics of new hybrids developed in the wheat improvement program. It was finally decided to examine the possibility of using flour particle size distribution for this purpose.

Published data (7,8) show that flour particles vary markedly in size even in the same flour, and that size distribution differs significantly among flours from various wheat varieties (3). The area in which the wheat is grown also influences size distribution. Severity of milling or grinding affects flour granulation and other properties (1,4). Fractions separated from the same flour according to particle size differ in chemical and physical properties, as well as in baking quality and mixing requirements (8,9,10,13,16). Harris (3) thought that particle size distribution may be a more sensitive measure of wheat milling quality than flour yield or ash content for experimentally milled flours. These observations demonstrate the importance of particle size classification determinations.

Shellenberger and his associates (16,17) showed that wheat endosperm particles do not invariably correspond in size to the apertures of the flour cloth through which they pass in the sieving operation. Silk flour cloths also impose limitations of mesh fineness, and the flour particles tend to agglomerate. Standard metal sieves contain apertures which are not subject to distortion by use and the flour particles passing through them are rigidly classified by size. Results obtained by Wichser, Shellenberger and Pence (17) and Harris (3) from metal sieves with the Ro-Tap shaker confirmed data secured by more empirical methods and yielded additional information about flour particle size.

Marked Difference

Harris in particular showed that particle size is markedly different in varieties of hard red spring wheat which are inferior in milling characteristics and flour yield from accepted standard varieties. Harris also showed that fractions of experimentally milled hard red spring flour separated by particle size yield essentially the same relations between particle size and ash and protein content as similar fractions from commercially milled hard red winter wheat flours. The fraction with the smallest particle size was poorest in mixing and baking properties for both types of flour.

These results show that information respecting particle size distribution may be obtained from both commercially and experimentally milled flour, and that differences in distribution between varieties found by the experimental mill will be reflected in the performance of these wheats in commercial mills.

The study described in this report was designed to supply additional information on the relative importance of varietal and environmental effects on particle size distribution, particularly the influence of wheats of probably inferior milling quality. The study was also enlarged to include comparisons between wheats grown in different years.

Table 1

Average Data for Wheat Varieties Grown at Six Stations Arranged in Order of Decreasing Flour Yield for Each Year

Variety	Test weight lb./bu.	Wheat protein %	Flour yield %	Ash %
1953—				
Selkirk	58.5	13.8	72.4	0.42
Rushmore	57.0	12.7	70.5	0.42
Lee	57.6	13.1	69.3	0.43
Thatcher	53.6	12.3	66.1	0.45
1954—				
ND 1	57.4	15.3	71.8	0.44
Selkirk	55.4	14.9	71.3	0.42
Rushmore	55.8	13.7	70.0	0.44
3880-227	57.9	15.0	69.8	0.44
3880-127	57.3	15.3	68.8	0.45
Lee	55.9	14.4	68.1	0.43
Minn. 2854	56.8	16.2	67.1	0.41
Willet	56.5	15.8	65.5	0.37
Thatcher	51.2	13.9	65.1	0.46

Table 2

Average Data for the Six Stations at Which the Varieties Were Grown. Arranged in Order of Decreasing Flour Yield for Each Year

Station	Test weight lb./bu.	Wheat protein %	Flour yield %	Ash %
1953 (4 varieties)				
Williston	59.7	13.2	71.9	0.42
Langdon	58.5	13.4	71.2	0.42
Fargo	59.0	11.6	70.6	0.50
Dickinson	55.8	14.2	68.5	0.36
Edgeley	52.8	13.4	68.2	0.43
Minot	54.3	12.9	67.1	0.43
1954 (9 varieties)				
Minot	56.4	13.6	69.4	0.38
Langdon	57.0	14.0	69.2	0.42
Dickinson	53.9	16.3	69.0	0.41
Edgeley	53.9	16.3	68.2	0.47
Fargo	57.5	13.9	68.0	0.52
Williston	57.0	16.5	67.9	0.36

Materials and Methods

The flours were long patents milled in the Allis from sound samples of hard red spring wheat grown at different locations in North Dakota in 1953 and 1954. The wheat varieties are shown in Table 1 and growth locations in Table 2. These tables also provide information on average test weights, wheat protein contents, flour yields and ash contents.

The methods used for preparing the wheat samples for milling, the milling, analytical procedures and the determination of particle size distribution have all been described (2,14, 15,17). Optimum sieving times had been ascertained previously for each of the standard Tyler sieves employed, using the Ro-Tap shaker and sieve cleaners (3). The overs were weighed as accurately as possible, and calculated as percent of the weight of flour used (50g.). A fresh sample

(Continued on page 10a)

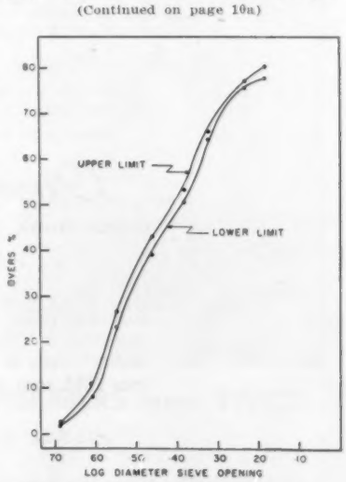

FIG. 2—Particle size distribution for flours milled from four hard red spring wheats grown at six stations in 1953 and 1954. Each dot represents 12 replications.

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Relative Humidity and Moisture Content of Flour

The moisture content of a substance is not a fixed characteristic but will alter with changes in the atmospheric conditions to which the substance is exposed. Whether any change which occurs in the moisture content during storage is a gain or a loss will depend upon the initial level of the moisture content and upon the relative humidity of the surrounding air.

It is the possibility that these two factors may lead to a loss of moisture—and hence to a loss of weight—that explains why packaged flour mixtures are scaled off at a weight in excess of that declared on the pack. Obviously the overage should not be larger than necessary because of the cost, but if it is too small, trouble could arise under the weights and measures regulations.

It is to the flour packer's advantage, therefore, to know something of the fundamental facts of relative humidity and about the effect of the relative humidity of air upon the moisture content of flour.

EDITOR'S NOTE: Associated with the packaging of flour is the problem of subsequent loss of moisture and loss of weight. Because of this weight problem, it is pointed out in the accompanying article, it is to the miller's advantage to know something of the fundamental facts of relative humidity and about the effect of the relative humidity of air on the moisture content of flour. This article is reprinted from the British journal Milling.

At any given temperature there exists a maximum quantity of water which can be contained in the form of vapor in a given volume of air. Water in excess of that quantity would assume the form of a mist or dew, i.e., minute droplets. The magnitude of that maximum quantity, i.e., the quantity that can be held before moisture in the form of discrete particles makes its appearance, varies with the temperature; the higher the temperature, the greater the maximum amount of water capable of being held in vapor form by a given volume of air.

Relative Humidity

The quantity of water actually present in a given volume of air at a given temperature when expressed as a percentage of the maximum amount of water capable of being held by that same volume of air at that same temperature is known as the relative humidity. To take an example: at a temperature of 70° F. one cubic foot of air is able to contain a maximum of 4.79 grains of water in the form of vapor, while at 90° F., one cubic foot of air will hold a maximum of 11.82 grains. If at 70° F. there were present in one cubic foot of air 2.39 grains of water, i.e., one half of 4.79 grains, then the relative humidity would be 50%. If the temperature of that one cubic foot of air were raised to 90° F., the

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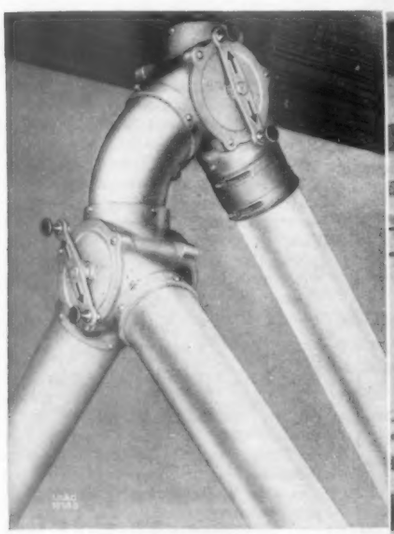

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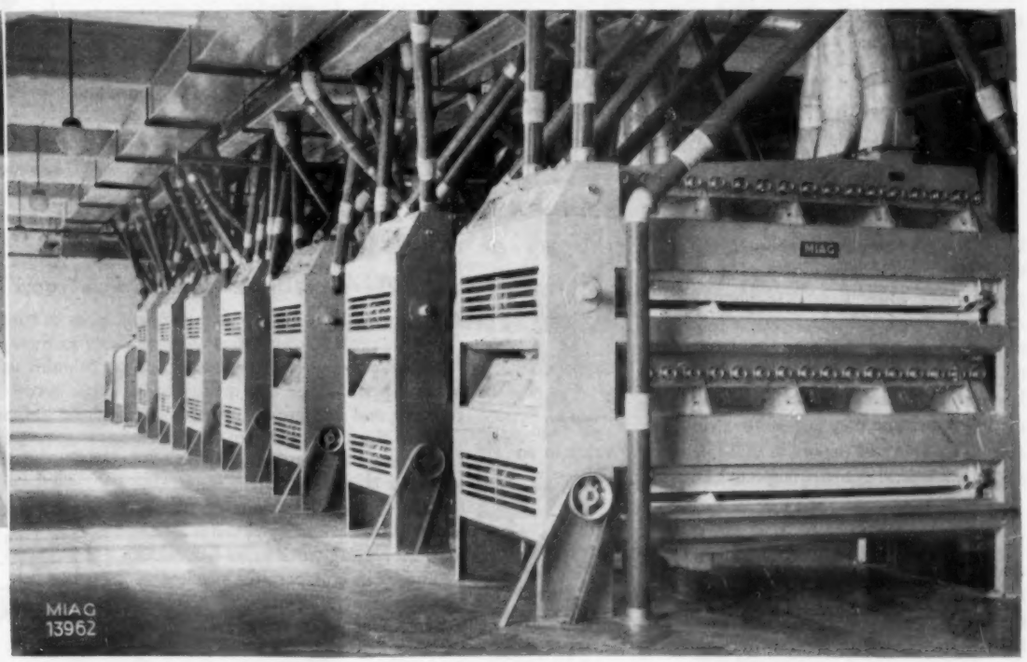

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contained 2.39 grains of water vapor would represent only 20% of the maximum amount containable at the temperature of 90° F., namely, 11.83 grains. Hence, this one cubic foot of air containing 2.39 grains of water vapor would have a relative humidity of 50% at 70° F. but a relative humidity of only 20% at 90° F.

It is obvious that since the relative humidity of a given mass of air varies with the temperature, it is possible by cooling air to reach a relative humidity of 100%. The temperature at which this occurs, i.e., at which the maximum amount of water obtainable is equalled by the amount actually present in the given mass, is called the dew point.

Dew Point Temperature

The dew point temperature of a given mass of air is, therefore, determined solely by the amount of water present in unit volume. Its relative humidity, on the other hand, is determined by this quantity and the existing temperature. Let us return to our earlier example in which we had one cubic foot of air containing 2.39 grains of water vapor. At 70° F. this quantity is 50% of the maximum containable in one cubic foot of air, and at 90° F. it is 20% of the maximum amount containable at that temperature. The dew point of this air will be that temperature at which 2.39 grains is 100% of the maximum containable by one cubic foot of air and reference to tables reveals that the maximum amount of water containable in one cubic foot of air is 2.39 grains at a temperature of 35° F. Hence, air containing 2.39 grains of water vapor per cubic foot always has a dew point of 35° F., but its relative humidity will vary according to its temperature, because relative humidity is the ratio of the fixed 2.39 grains to the maximum amount of water the air can hold and this latter is dependent upon temperature.

The lower the relative humidity of air, i.e., the smaller the fraction of the maximum amount of water retainable that is actually present, the greater the quantity of water the air can take up and hence the greater its drying power. As the temperature of the air containing a given proportion of water vapor rises, therefore, its drying power increases, even although its absolute water content remains the same, because its relative humidity decreases.

Approximate Equilibrium Moisture Contents

The effect of the relative humidity of the surrounding atmosphere upon the moisture content of a material varies according to the firmness with which the material holds its moisture. Hence, at any given relative humidity different substances will attain different moisture levels, and there may be some variation in the equilibrium moisture contents of different samples of the same material, arising from differences in the history and nature of the samples.

The equilibrium moisture contents of flour exposed to various levels of relative humidity have been studied by a number of investigators. There are not unexpectedly some differences between their findings but their results would suggest that the approximate equilibrium moisture contents of flour exposed to various levels of relative humidity are as follows:

Relative humidity of surrounding air	Approximate equilibrium moisture content
%	%
30	9.5
40	11.0
50	12.0
60	13.0
70	14.5
80	16.5

It follows from the foregoing figures that many present day flours will undergo loss of moisture if the relative humidity of the air to which they are exposed drops much below 70%. The rate at which moisture will be lost from a flour which has a moisture content above the equilibrium moisture content for the relative humidity to which it is exposed will vary according to the nature of the container in which it is stored and also according to the size of the pack. The larger the pack, the more slowly will the flour lose moisture and hence the more slowly will its weight decrease. This means that criticisms on the score of underweight are more likely to arise with 1-lb. bags than with 3-lb. bags, and with 3-lb. bags than with 7-lb. bags. The effect of the nature of the container is related to its permeability to water vapor and accordingly weight changes will occur more readily in flour packed in cotton bags than in flour packed in paper containers.

Rate of Change

The rate of change of moisture content and of weight of flour stored in a given type of pack will depend upon the magnitude of the difference between the environmental relative humidity and the equilibrium relative humidity for the initial moisture content of the flour. When the difference is large, so that a considerable gain or loss of moisture can be expected, the moisture content will change rapidly during the first 7 to 14 days of storage and thereafter much more slowly. It is not unusual to find that as much as 80% of the total moisture lost during 10 weeks' storage at a very low relative humidity, say, 35%, disappears during the first 14 days.

The removal of moisture from

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INSIDE SCIENCE

The Vital Story of BREAKFAST CEREALS

with essential vitamins and minerals restored

by Science Writer

This article is one of a series devoted to the story of vitamin enriched or restored cereal products: white bread and rolls, white flour, corn meal and grits, macaroni products, white rice, breakfast cereals, farina.

Increasing in popularity over the years, breakfast cereals are used throughout the United States by young and old alike. Eaten with fruit and milk or light cream, they contribute an excellent combination of basic, flavorful, nutritious foods to the diet.

In the past decade the use of these fine foods has grown markedly. In fact, it is estimated that there has been a 20% increase during the period. In 1953 the increase was much higher than the average of previous years. It was 5.5%.

During 1953, for example, many tons of breakfast cereal foods were eaten in the United States. Industry figures show that 4.6 pounds of dry cereals and 2.5 pounds of hot (cooked) cereals per person were consumed.

Many grains are processed to make breakfast cereals: wheat, corn, rice, oats. Often these foods may be eaten just as they come from the manufacturer's package. Or they may require only a short period of cooking to be ready for the table. They appeal to busy home-makers, as well as to institutional dietitians, because they are readily available in a variety of flavors to add interest and value to an important, but sometimes neglected, meal.

A Nutritional Advance

As the science of nutrition advanced in recent years, it was found that losses of essential vitamins and minerals occurred during processing of wheat, corn and rice into breakfast foods. When this became known, most manufacturers acted to overcome the losses. They adopted restoration.

Restoration simply means that certain vitamins and minerals are added to the cereal food during processing so that the finished product is generally equal to the whole grain values of those elements. The vitamins thiamine (B_1), riboflavin (B_2), and niacin as well as the mineral, iron, are used in restoration. Vitamin D is also added sometimes.

The recent trend toward pre-sweetened cold cereals for breakfast consumption and between-meal snacks emphasizes the nutritional importance of vitamin fortification. Increased calories require more "B" vitamins for proper utilization.

What the Vitamins Do

Thiamine is the vitamin which helps to build and maintain physical and mental health. It is essential for normal appetite, intestinal activity and sound nerves.

Niacin, which is another of the "B" vitamins, is needed for healthy body tissues. Its use in the American diet has done much to make a serious disease called pellagra disappear.

Riboflavin is the vitamin which is essential for growth. It helps to keep body tissues healthy and to maintain proper function of the eyes.

Vitamin D is important to prevent rickets in children and the development of certain abnormal bone conditions in adults.

Iron is essential for making good red blood and for preventing nutritional anemia.

Where Do The Vitamins Come From?

At about the same time that processing losses in breakfast cereals became known, other developments in the science of nutrition produced ample supplies of vitamins at economical prices. Thus, the quality of breakfast cereal foods could be, and was, greatly improved through restoration.

Since the early days of breakfast food restoration and of white flour and white bread enrichment, the world-famous firm of Hoffmann-La Roche has supplied top quality vitamins by the tons. Pioneering work in its laboratories and by its collaborators resulted in the "duplication" of some of Nature's extremely complex substances. First, the chemical composition of the vitamin was learned. Second, the pure substance was isolated. Third, the "duplicate" was made by synthesis. And fourth, the laboratory techniques were extended to large scale operations.

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flour by exposure of the flour to an atmosphere of low relative humidity diminishes its hygroscopicity, i.e., its affinity to water vapor, with the result that exposure of the dried flour to an atmosphere of high relative humidity does not lead to the original moisture content being regained. Moreover, the re-absorption of moisture from the surrounding air of high humidity proceeds at a slower rate than did the loss of moisture in an atmosphere of low relative humidity. In one experiment recorded in the literature the moisture lost from a flour by an over-night exposure to a relative humidity of 40% was not fully regained after 17 days' storage in an atmosphere of 75% relative humidity.

Overage to Allow for Loss of Weight

The flour packer will want to know what practical interpretation he should place upon the foregoing facts. In other words, what overage should he allow for loss of weight during storage? If the maltose content of his flour is high and it is likely to be stored at a low relative humidity, he must allow considerable overage —flour of 15% moisture stored at 40% relative humidity would need an overage of ¾ oz. per pound in order to prevent short weight packages—but if the moisture content of his flour is low and it is to be stored at a high relative humidity, he needs no overage because the pack would increase in weight. He can determine the moisture content of the flour but he cannot forecast the relative humidity at which it will be stored and he can, therefore, only choose an overage which should prevent his packages becoming under-weight provided they are not subjected to an unusually low relative humidity for a considerable period of time. The overage required to prevent packages of flour of different moisture contents from becoming underweight when stored at various relative humidities are shown in the following table:

Relative humidity	Drams overage required per pound to prevent underweight when packed at following moisture contents		
	13%	14%	15%
40%	5½	8¾	11¾
50%	2¼	5½	8½
60%	...	2¼	5½
70%	...	...	1½

These figures make clear the economic advantage of having a relatively low moisture content in flour which is to be retailed in small packs, an advantage which is additional to the beneficial effect of such practice upon the keeping properties of the on the keeping properties of the product, particularly if self-rising ingredients are present.

—BREAD IS THE STAFF OF LIFE—

Check Sample Work For 1955 Announced

COLLEGE PARK, MD.—Collaborative check sample work, sponsored by the American Feed Manufacturers Assn. and the Association of American Feed Control Officials, will again be available in 1955, according to L. E. Bopst, secretary of the feed control group.

The two associations for many years have been conducting this work on feeds in order to obtain greater accuracy among laboratories.

During 1954 there were 150 participants in the work. The program and forms for the 1955 work have been forwarded to these participants by Mr. Bopst.

The service is available to others, and anyone interested should write for full information to L. E. Bopst, New Chemistry Building, University of Maryland, College Park, Md.

A series of seven samples for one program and a series of six samples for a second program—prepared by Law & Co., Atlanta, Ga.—will be forwarded at intervals during 1955 to participants. The cost is $10 for each program, to cover expenses involved.

The samples include feeds with various ingredients and various feed ingredients.

—BREAD IS THE STAFF OF LIFE—

A. J. WEISENBERGER DIES

MIDWAY, KY.—Augustus J. Weisenberger, 62, operator of a flour mill here for 40 years, died in a Lexington, Ky., hopsital recently.

Bulk Flour for Bakers

By Leigh Paulsen
Atkinson Milling Co.

We are witnessing a rapid acceleration into a new era in flour handling, bulk flour transportation. Efforts are being concentrated to increase the size of the units of flour handled, and to mechanize and speed the loading, unloading and handling of these units.

We, at Atkinson Milling Co., have long been conscious of the need to develop an efficient bulk handling system. We have found that there are four major requirements for the most efficient bulk handling system: (1) bulk storage; (2) bulk haulers; (3) high capacity, efficient and sanitary loading and unloading systems, and (4) a customer with bulk storage.

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EDITOR'S NOTE: The accompanying article on bulk flour handling is from the Bulletin of the Association of Operative Millers.

up a blend of flour and run an analysis on the flour before loading starts. This also facilitates using a system to load a trailer or railroad car in a minimum of time.

The second part, namely the hauler, is being supplied by the railroad car and the truck trailer manufacturers. We have used and are using both types of haulers at the present time.

The trailer has a capacity of about 400 cwt. flour. The bottom of the trailer body is formed by two hoppers running the length of the trailer, with a screw conveyor located at the bottom of each hopper. At the center of the trailer and under each screw we have installed one of our actuators. The screws are arranged in such a manner as to convey the flour from the ends of the truck to the center. At the center the actuators mix the flour with air in preparation for conveying. Blowers, mounted on the trailer, compress the air which conveys the flour from the truck to the baker's bin. The unit we have in operation at the present time is unloaded at the rate of 800 lb. per minute, the flour being conveyed about 130 ft. to the bakery bin. The machinery necessary to unload the truck is mounted on the truck, and all of the power is derived from electric motors using electricity from the bakery. The power cable used between the truck and the bakery is carried on the truck. An electrical receptacle is placed outside the bakery near the unloading area. The hose for connecting the bakery receiving pipe to the actuator is stored in the bakery.

The third part of the bulk transportation system is the loading and unloading equipment. In our work with loading and unloading systems, we used air as the conveying medium, with the emphasis on using as little air as possible. With this in mind, we designed our system of actuators to fluidize the flour with a minimum of air in such a manner that the combination will flow through a pipe. The use of air gives us flexibility in placing our conveying lines. We are able to make use of a combination of curved and straight pipe in the same system. The small quantity of air used makes it possible for us to use a small, simple bag filter to separate the air from the flour at the bin.

I have already discussed one application of the actuator for unloading, that is actuators mounted directly on the truck. Another method which can be used is to put a conveyor of some type between the truck and actuator. In this case the actuator would be mounted permanently at the unloading station. The conveyor would be located in a pit under the truck or rolled under the truck during unloading. These systems will work equally well and each has its application.

Our loading system makes use of the same component parts as the unloading system. In this case we have located the actuator permanently under two of our storage bins, and one under a rebolt system. From the actuator the flour travels through a pipe to the truck or railroad car to be loaded. At the bulk unit we have two systems to distribute the flour in the unit.

The first of these systems, the specially designed filling tube, a 4 in. tube, is fastened to the ceiling of the truck or car. Every 12 in. a 90° section 10 in. long is cut from the bottom of the tube. As the flour blows into the bin it falls through the sections cut from the pipe and piles up near the inlet first. As the bin fills, a complete pipe is formed with the flour filling in the sections previously cut out of the pipe. We have had very good results with this system. It is very efficient since once it is set up, it needs to be checked only occasionally to determine filling progress.

Since all bulk units are not equipped with this filling pipe, we have had to devise another loading system. For these units, we introduce the flour through the manholes, using a special cover resembling an inverted periscope. A 4 in. pipe passes through the cover and fastens to a 90° elbow. The cover is built so that the elbow may be pointed in any direction from the outside without removing the cover. The momentum of the air and flour is sufficient to carry the flour to the corners several feet away. While this system is satisfactory, it requires regular attention to direct the flour to each and every corner of the railroad car.

As for filling efficiency, these systems are about equal. They both pile the flour to the ceiling at places and at others doesn't quite reach the ceiling.

The final phase of bulk flour trans-

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portation is the baker's bin. For each baker there is a different system of flour storage. We have been concerned with two types of storage. The first is the 30 cwt. portable bins. To facilitate our filling these bins, the bakers have lined up enough of these bins in a row to handle the capacity of our truck. Over this row of bins is placed a screw conveyor with an opening over each of the bins and a cloth sock between the conveyor and pin. As the bins become full, the flour carries over into the next bin. This process continues until all of the bins are filled. After the bins are filled and the truck has left, the baker replaces the bins with empties and he is ready to receive the next load.

The next type of storage is the long, low, horizontal bin installed permanently in the baker's present warehouse or basement. Because of headroom limitations, this type of bin is attractive to many bakers. These bins are emptied through a center discharge via two parallel screws running lengthwise along the bin bottom. From the bin screw, the flour goes to the sifter over the mixer scales. Bins of this type have the advantage of being permanent, and at the same time their cost is not excessive since few changes in building construction are necessary.

A multistory bulk storage unit is, of course, the best of the bulk storage plans. Here the bins are vertical, with a hopper and a small feeder at the bottom. They are grouped close together and should be near the unloading area. The filling operation is then independent of the other activities in the bakery. Since this type of storage has the highest initial cost, especially for the existing bakery, they are not too numerous.

A general principle to follow in constructing any bulk storage with regard to bulk loading and unloading operations is this: Design it so that bulk loading and unloading operations do not interfere with any other operation at the mill or bakery. If the bulk loading or unloading station coincides with the receiving dock, sooner or later the bulk truck will be delayed and delays cost money.

As I have outlined bulk flour transportation, there is a considerable sum of money involved to install the complete system. Why should the miller bother with it? Where are the savings for the miller?

Savings through the use of bulk transportation come in many ways, depending upon present methods and facilities. For the sake of illustration, let us consider the loading of 400 cwt. into a bulk truck versus a regular truck.

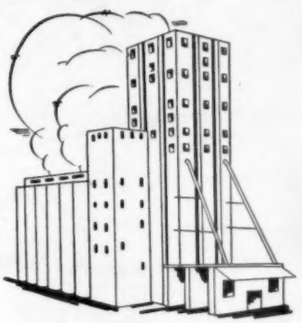
Using our operation as an example, it takes less than one manhour to load our bulk truck from the bulk storage, and only one man is involved in the filling job. Now let us consider the loading of 400 sacks into trucks. Assume that two men pack at the rate of 250 sacks per hour. Then it requires 3.2 manhours to pack the flour. At the same time it requires 3.2 manhours to place the flour on the warehouse floor. To load 200 sacks into a truck trailer takes two men about 15 minutes, or about one manhour to load 400 sacks into two truck trailers. Adding this up gives a total of 7.4 manhours to load 400 sacks into trucks. In this case, a saving of 6.4 manhours for each 400 sacks. Consider also that in the sacking operation it is necessary to have about six men available, whereas in the bulking operation only one man is necessary. Consider also that in the unloading operation a similar savings can be made. This is of great importance to the baker and to the operator of a bulk blending plant.

Another advantage of bulk transportation is concerned with a sanitation both around the loading area and with the control of infestation.

Referring again to our truck operation, loading the truck consists of (1) positioning the truck in the loading area, (2) connecting the filling hose to the filling tube in the truck and starting the motors driving the equipment. The operation is sealed to the outside from the bulk bin to the truck or vice versa. For all practical purposes there is no flour spilled at the mill or at the bakery; nor does any foreign material get a chance to enter the flour. It is, so to speak, "untouched by the human hand." Once the filling tube is connected to the truck, neither foul weather nor human hand can touch it.

Infestation-wise, the metal construction and absence of dead spots affords the insects few places to breed undisturbed. To date, after 18 months of operation, we have found no indication of any infestation of our bulk transport nor in any of the loading equipment. This means that flour insect-free at the mill will arrive insect-free at the bakery. The equipment is relatively air tight, so that if it became necessary, a very effective fumigation job may be carried out.

One of the largest and most obvi-



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Timely application of Dusta-Cide will forestall surface infestation or reinfestation at a fraction of the cost of fumigation—**from about 1/5 for shallow flat storage to 1/25 for the tallest bins.**

Dusta-Cide provides a protective layer of dust over a grain surface. Its ingredients have a very low level of toxicity. Moreover, the ratio of dust to underlying grain makes the toxicity factor negligible. The product leaves no objectionable odor.

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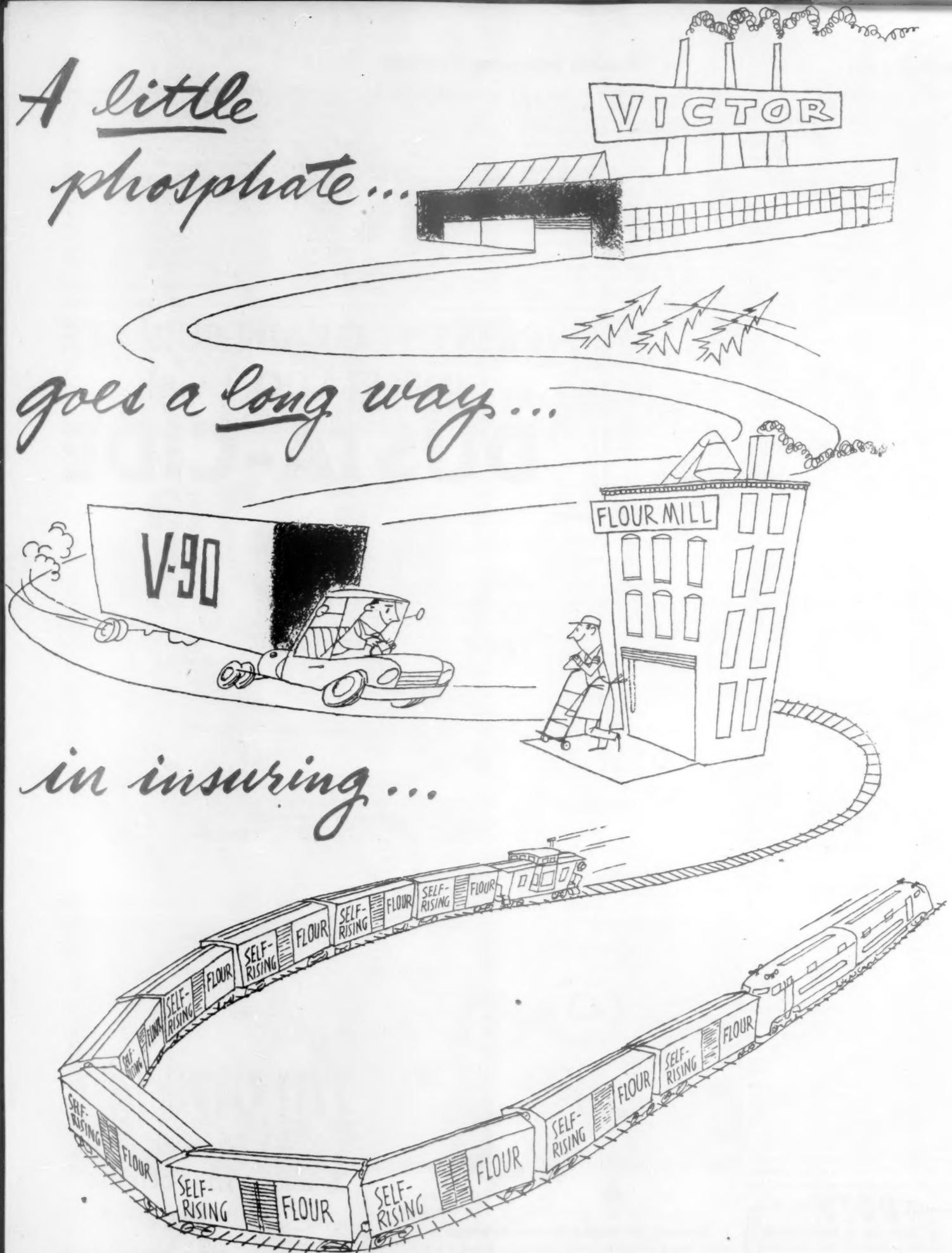
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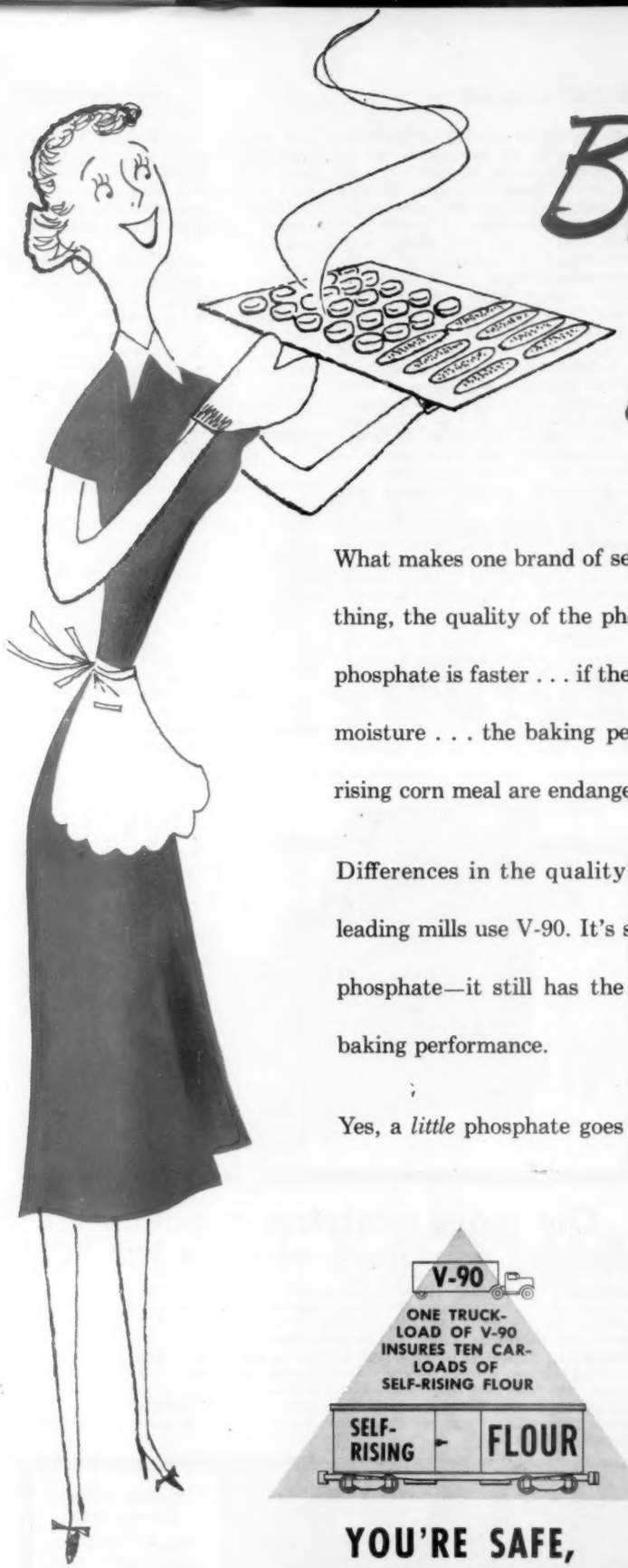

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Yes, a *little* phosphate goes a long way. One 5-ton truckload of phosphate will make ten 30-ton carloads of self-rising flour! So it's easy to see that the phosphate you use can affect baking performance (and repeat sales) in thousands of homes. It's better to play safe and be sure. Specify V-90.

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ous places for savings in the bulk system is in the elimination of the bagging operation. The cost of a bag, paper or cotton, seems to average (counting the sale of used bags) about 10¢ per bag. On a 500 cwt. load, that is $50. This saving is of importance to operation of blending plants. Around any pile of sacked flour there is some sifting out of flour. Although this is a small loss, and it probably costs more to sweep it up than the flour is worth, it is a definite loss. Another saving is in broken bags. Although the route from the packer to the boxcar is a smooth chute, a flat belt, and the soft touch of the loader's hand, bags do break, spill, and generally distribute flour around the loading area. With bulk transportation there is none of this. No bag to store, break or provide a means of scattering flour. Freight claims on broken bags disappear and a considerable amount of gray hair and the gnashing of teeth is saved, not to speak of the money involved.

Flexibility

Flexibility is another of the advantages of bulk handling systems. If you are short of track space adjacent to the dock, use the next track over. A fluidizing loading system such as we use will convey the flour to the car in a fast, efficient and sanitary manner. Similarly, no dock is needed to load or unload a bulk truck. All you need is space to park the truck as near to the loading facilities as is possible and the bulk loading system will fill the unit while you wait.

If, on the other hand, your flour bins are not adjacent to the parking area, then all that is necessary is a space for a 3 in. or 4 in. diameter pipe between the bin and the truck. If the going is extremely rough, a flexible rubber hose may be used in place of the metal pipe that I suggested earlier.

PARTICLE SIZE

(Continued from page 1a)

of flour was employed for each separate determination using one sieve at a time. Micka and Vrana (10) reported that it is impossible to obtain consistent results when one sieve is placed above another because of variations in the rate and completeness with which flour passes from one sieve to another.

Varietal and Stations Data

Four varieties were grown at all stations in both 1953 and 1954, as shown in Table 1. For 1953 the Ca-

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Table 3

Analysis of Variance of Particle Size Distribution. Data From Nine Varieties Grown in 1954

Source of variation	Degrees of freedom	Sums of squares	Variance
Between sieve sizes ..	7	340785.1	48683.6**
Between varieties	8	4107.0	513.4**
Between stations	5	284.5	56.9**
Interactions			
Sieve sizes x varieties	56	1103.4	19.7**
Sieve sizes x stations	35	418.5	12.0**
Varieties x stations	40	437.6	10.9**
Sieve sizes x varieties x stations (error)	280	600.0	2.1
Total	431	347736.1	

Note: **Shows that the 1% level of significance was exceeded.

nadian variety Selkirk was highest in test weight, wheat protein content and flour yield, while Thatcher was the lowest of the four varieties in these properties. The flour ash content of Thatcher was also slightly higher. In both 1953 and 1954 stem rust race 15 B was quite prevalent in North Dakota. Thatcher is the most susceptible of these wheats to stem rust 15 B, which probably accounts for its inferior quality in these tests.

For the 1954 group, ND 1, a hybrid now being tested for possible later release as protection against 15 B stem rust, was superior to Selkirk in test weight and flour yield, although 3880-227 was slightly higher in test weight than the other varieties. This variety also has resistance to 15 B. Thatcher was again the lowest in test weight and flour yield and highest in flour ash content. Minn. 2854 and Willet were superior in wheat protein content, relatively high in test weight and low in flour ash. For flour yield they were lowest of all the nine varieties except Thatcher.

Similar data for the six stations are shown in Table 2. For 1953, when four varieties only were included, the wheats grown at Williston were highest in test weight and flour yield, while Minot produced wheat with the lowest flour yield. For wheat protein content Fargo was definitely lowest among the stations. For flour ash Fargo was high, Dickinson low. In 1954, when nine varieties were grown, the station averages were quite different from 1953. Minot wheats gave the best flour yields and were next to the lowest in flour ash. Williston was at the bottom in flour yield, with lowest flour ash. The inclusion of five more varieties in this comparison tended to change the relative position of the stations from that of 1953. Fargo again produced the lowest wheat protein, but only 0.6% below Minot.

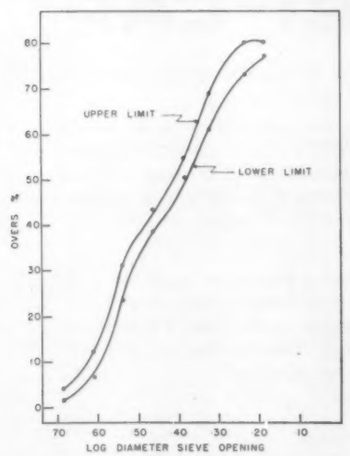

FIG. 3—Effect of location of growth upon the particle size distribution of flours milled from four hard red spring wheat varieties in 1953 and 1954. Twelve replications are represented. The distributions for the six stations fall within the limits shown.

Because of the difference in number of varieties grown in each year valid comparisons between 1953 and 1954 are difficult. Protein content, however, appears to be significantly higher for each station in 1954. It is probable that other differences between the two years are not important.

Results and Discussion of Particle Size Analysis

Table 3 shows the analysis of variance of the particle size distribution data for the nine varieties grown in 1954. All the variances are significant at the 1% point. The relative magnitudes of the variances between sieve sizes, varieties and stations indicate that the effect of size of sieve aperture was the most important single factor causing variation in particle size distribution. The effect of varieties was less than that of sieve size, but greater than that for stations. Harris (3) reported that the varietal effect on size distribution was greater than that of stations, but the inclusion of two varieties of abnormal milling characteristics in the present study increased the variation accounted for by varieties until it became much greater than the variation caused by stations.

Figure 1 illustrates the effect that varieties which differ in milling characteristics from those of standard accepted wheats have on the particle size distribution curves. The logarithm of the diameter of the sieve aperture is used rather than mesh number (15). Seven hard red spring wheat varieties that have been found to be satisfactory in milling properties had flour particle size distributions distinctly below the lower limit of the seven other varieties. Thus Willet and Minn. 2854 produced flours of finer granulation than normal for hard red spring wheat, resembling

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soft winter wheats, although they were the highest in protein content of the group.

No relation between wheat protein content and vitreousness, as assessed by particle size distribution, was found. These data exemplify the care necessary in a wheat breeding program to guard against the release and general growth of new varieties which may excel in field properties, and even in several quality factors, but are seriously deficient in one or more of these factors.

The interactions are of more or less practical interest. Briefly, the varieties did not react in particle size distribution in the same manner with the various sieve sizes. The same is true, to a lesser degree, with the stations at which the wheats were grown. Also, the varieties did not react similarly at all stations, their particle size distribution being differentially affected by their place of growth.

Table 4 separates out the effect of sieve size, variety, station and year of growth on particle size distribution. Here we have four causes of variation instead of three as before, but the form of the analysis remains essentially unchanged. The influence of sieve size naturally is still much the greatest, while the next largest effect is due to the new factor introduced, year of growth. The variation caused by stations is greater for this experiment than for the first one discussed, because the four varieties were of acceptable milling quality and had been approved for release. This result corresponds with the former report of Harris (3). Figure 2 represents the spread in particle size distribution between the flours from the four varieties. They all fall within the limits represented, resembling the

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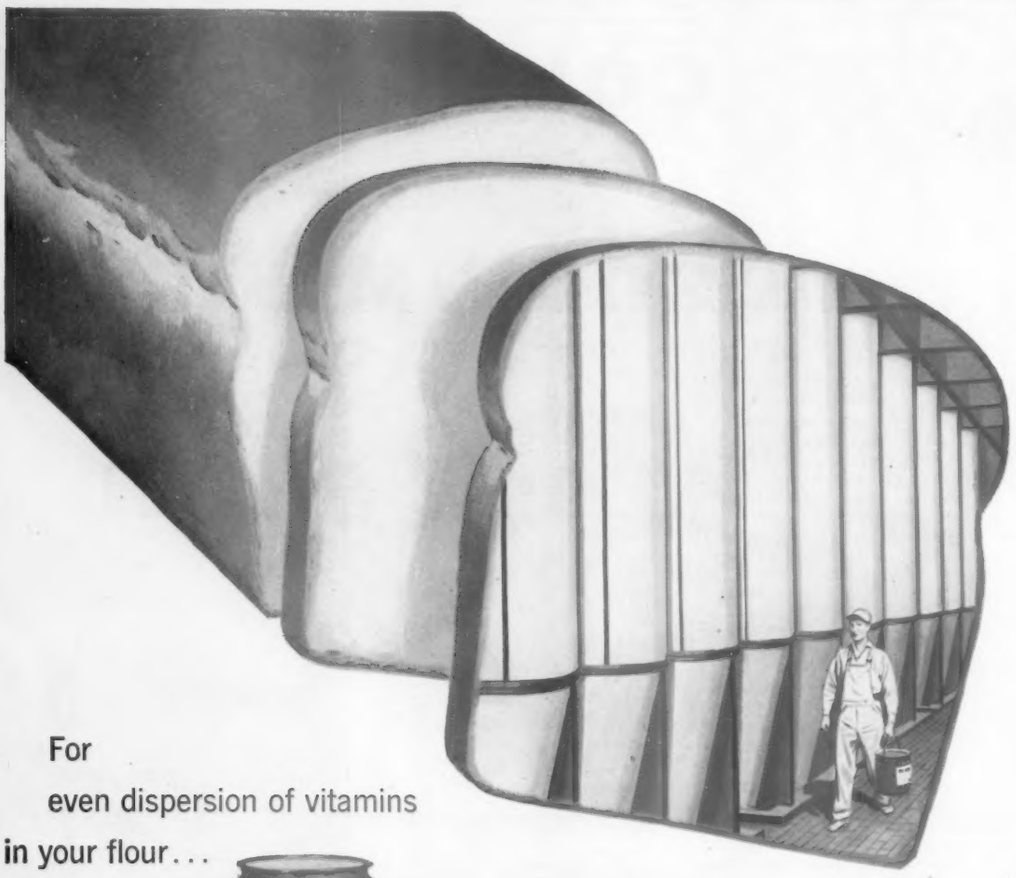

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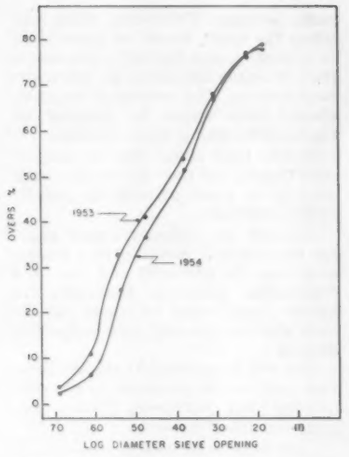

FIG. 4—Effect of year of growth upon the flour particle size distribution of four hard red spring wheat varieties grown at six stations in 1953 and 1954. Twenty-four replications are represented.

distribution shown in Figure 1 for the seven varieties of good milling characteristics. Figure 3 shows the range among stations for the two years. The distribution falls between the limits given. Figure 4 illustrates the difference in distribution between 1953 and 1954.

There are three additional interactions in Table 4 as compared to Table 3. These include the interactions of the three original causes of variation with years of growth. The interaction between sieve sizes and varieties is not significant; in other words, these varieties approximately equal in milling quality reacted similarly to differences in sieve mesh. The interaction between stations and years was markedly larger than the others, indicating that the difference in response of the stations to annual weather variations was the most important. The varieties also responded differently to yearly influences but in a less striking manner. The remaining three interactions, while all very significant, were not as large as those involving varieties, stations, and years.

Microscopic examination of the flours indicated that Willet and Minn. 2854 had particles with ragged edges, while the other flours had particles which showed clean-cut, sharp edges, confirming a priori expectations of differences between flour particles from these two wheats.

Summary

The particle size distribution of hard spring flour is influenced very significantly by wheat variety, location and year of growth. Of these three causes of variation, that of years appears to be the most important. The comparative magnitudes of the effects of varieties and year vary with the milling quality of the variety being examined. When wheats of inferior milling properties are included, the effect of varieties becomes larger than that due to location of growth.

While infection with 15 B stem rust reduces test weight, protein content and flour yield, it does not affect the particle size distribution of susceptible varieties, thus permitting a direct comparison between susceptible and resistant wheats regardless of rust infections.

From these results it seems that a knowledge of flour particle size distribution aids in assessing the general milling quality of new wheat hybrids before they are released for farm growth. This confirms the former conclusion of Harris (3) based on less extensive data.

Table 4

Analysis of Variance of Particle Size Distribution. Data From Four Varieties Grown in 1953 and 1954

Source of variation	Degrees of freedom	Sums of squares	Variance
Between sieve sizes ..	7	287489.7	41070.0**
Between varieties ...	3	221.4	73.8**
Between stations	5	1046.4	209.3**
Between years.	1	883.7	883.7**
Interactions			
Sieve sizes x varieties	21	216.6	10.3
Sieve sizes x stations	35	494.2	14.1**
Sieve sizes x years	7	69.9	10.0**
Varieties x stations	15	132.6	8.8**
Varieties x years	3	133.2	44.4**
Stations x years	5	855.1	171.0**
Higher interactions (error)	281	1889.0	6.7
Total	383	293431.8	

Note: **Shows that the 1% level of significance was exceeded.

Acknowledgment

The authors are indebted to John Sullivan for constructing the figures in this report.

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——BREAD IS THE STAFF OF LIFE——

STRADER-HUGHSTON MOVES

DALLAS — The Strader-Hughston Co. has moved its offices to quarters in its new warehouse on Coit Road between Forest Lane and Valley View Road, north of Dallas. The firm's address is Route 7, Coit Road. Ralph Strader, Tom H. Hughston and J. D. Smith are associated in the business, which handles feed ingredients and milling and ginning machinery.

——BREAD IS THE STAFF OF LIFE——

HYMAN REICHERT DIES

MINNEAPOLIS—Hyman Reichert, who had been associated with the American Bag Co., Minneapolis, since 1936, died Jan. 19 while on a plane flying from Spokane to Minneapolis. He was 45 years old and had been a lifelong Minneapolis resident.

Quality
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Are Synonymous with

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Designers and Engineers for Mills, Elevators and Feed Mills
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CORRALLOY TOOL CO.
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One machine - or a mill-full - here's the COMPLETE SERVICE

'Pneu-Flow' can be used for smut department or mill. This shows a line of mill system cyclones.

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OF ROCHDALE, ENGLAND

WORLD-RENOWNED Robinsons. A *complete* service. Milling equipment and planning that's way ahead. (Depend on Robinson genius to do the whole job.) Research—design—manufacture—installation. Order one machine . . . two . . . a mill-full, you're sure of that *complete* Robinson service.

Milling engineering is more — much more than machinery. (Robinsons know that.) It's fresh, workable ideas . . . the ability to understand thoroughly *every* aspect of this essential world trade. (And Robinsons do.) Go to Robinsons with a milling problem and they'll provide the answer. See how Robinsons take a keen, lively interest in every project.

The answer probably lies in one of the many revolutionary Robinson developments that has come from their Research Department over recent years. (Developments that are rapidly changing the face of milling.) There's 'Pneu-Flow' — choke-proof pneumatic conveying for mill and smut department.

In the smut department 'Pneu-Flow' works with specially-designed, all-metal machinery. From Robinsons, too, comes 'Pneu-Roll' rollermills — streamlined, sturdy . . . extra sensitive (other important developments include the Robinson Plansifter with high-capacity and quick release arrangement) and 'Pneu-Spout' — easily-erected, versatile, space-saving metal spouting.

Far-reaching research linked with a deep understanding of your needs is the basis of Robinson fame—providing you with a complete service.

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Lubrication Charts Are Valuable Aids

It goes without saying that the most important function of the maintenance man in a feed plant is to lubricate all machines and equipment in accordance with the manufacturers' recommendations.

However, in setting up a good preventive maintenance program, there are certain questions to be answered. How are management and the maintenance man to know which bearing is to be lubricated next, especially when there is such a wide time in'erval range recommended for different bearings? When were they lubricated the last time?

In this connection, G. A. Carlson, chief mechanical engineer of the Strong-Scott Manufacturing Co., Minneapolis, recently pointed out that some firms are using lubrication charts for each machine in the plant. These individual machine charts are usually 8½x11 in. and are placed in a notebook for ready reference by the maintenance man or management. The name or number of the machine is placed on top of the chart with a column on the left side listing each point of lubrication on the machine. The next column may list the type of lubrication to be used, and following this is the column showing the recommended time lapse interval for each bearing. Following these columns the sheet should be squared off to provide spaces for the maintenance man to enter the dates he lubricates each bearing. The bottom of the sheet should have space for general remarks concerning each machine.

It will take some time to prepare such charts, but they are really necessary in a good preventive maintenance program.

You can use ordinary ledger paper for the charts if you like, or a master chart can be prepared and run on a duplicating machine. However, the blank charts must be made out for each machine to suit your individual desires.

You will be amazed at the information that can be available to you concerning your machinery from a well prepared chart system.

—BREAD IS THE STAFF OF LIFE—

NEW JERSEY FIRE

JERSEY CITY, N.J.—A grain elevator shaft at the foot of Caven Point Road, Jersey City, N.J., owned by the Lehigh Valley Railroad, burned recently. Little damage was caused to the grain.

—BREAD IS THE STAFF OF LIFE—

ILLINOIS FIRE

WELDON, ILL.—Some damage resulted from a smoldering fire in the Weldon (Ill.) Grain Elevator recently.

Need New Rolls?

In addition to our roll corrugating and grinding service for the flour milling industry, the Twin City Machine Co. also supplies new rolls, and we will be pleased to receive your inquiries.

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58 Years have changed a lot of things!

...including DUST CONTROL

Licensed by H. J. Hersey, Jr.

Diagram of operating design of filter tube. (Available in multiples of 4, 8, 12, 16 & 32)

OUTSTANDING DAY ADVANTAGES

- 99.99+% Filtering Efficiency
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Handles 5 times more dust laden air per square foot of cloth than conventional dust filters.

The automobile has changed America's living habits and the DAY High Pressure Reverse Jet Filter has changed dust control methods. To match the challenge of changing times and changing needs DAY leadership revolutionized the control of dust by utilizing the Hersey principle of filter cloth cleaning with HIGH PRESSURE REVERSE JET AIR. This advanced type of filter handles FIVE TIMES MORE DUST LADEN AIR per square foot of filter cloth than conventional filters.

There is nothing that will match the high on-the-job efficiency provided by DAY filters. It is a proven fact that one DAY filter recommends another. 87% of DAY filter users have ordered additional DAY Reverse Jet Filters.

DAY gives you tremendous savings in valuable plant space, installation and maintenance costs. For maximum filtering results from a minimum filter investment write to DAY for Bulletin 528-R.

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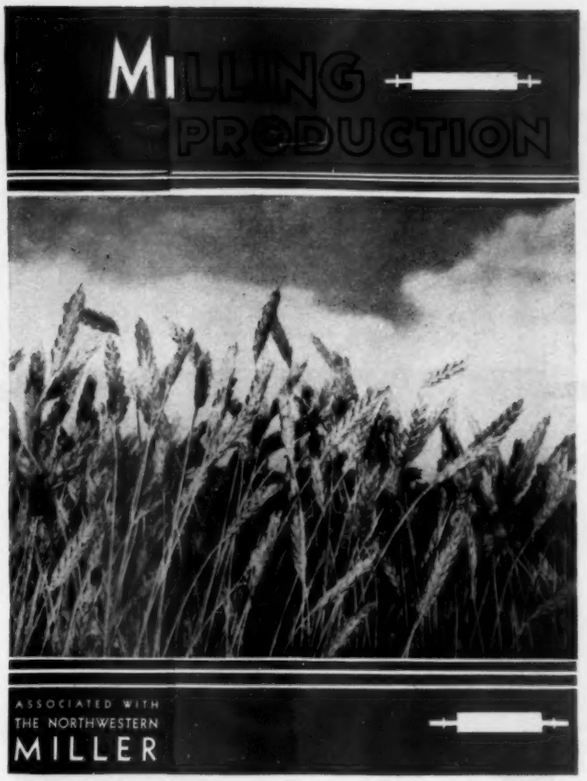
STOP AIR POLLUTION with DAY DUST CONTROL



TRIPLE YOUR ADVERTISING EFFECTIVENESS

1. WORKING CIRCULATION —Studies of flour manufacture show that 320 of the flour mills in this country produce 98% of the flour. Milling Production with its controlled circulation reaches more than 900 key men in these important flour mills. This working circulation provides contact each month with the people who directly or indirectly control the buying—superintendents, operative millers, chemists and plant managers. *There is no waste circulation—only working circulation* — and you are assured of reaching your potential customers in the most productive mills.

2. LEADERSHIP MAKES READERSHIP — Readership surveys and unsolicited correspondence from its readers attest to the editorial leadership of Milling Production. That editorial leadership is held by complete words-and-pictures reports of the latest milling technology, current news, features and complete coverage of the activities of the industry's two technical associations. *The real price the reader of a publication pays is the amount of time he puts in reading that journal.* Over one half of the readers of Milling Production have requested that it be sent to their homes so that they may enjoy uninterrupted reading pleasure.

3. DOUBLE-DUTY DOLLARS —Money spent for advertising in Milling Production does double duty. In addition to reaching the production personnel, the advertiser's message is read in the Milling Production Section of The Northwestern Miller by the executives who approve purchase orders. *No other advertising medium in the flour milling industry offers this double-duty feature of reaching both groups* — mill technologists and executives—with the same advertising message and for the cost of one advertisement. Take advantage of this 100% coverage through one double-duty advertising contract.

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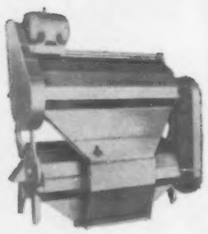

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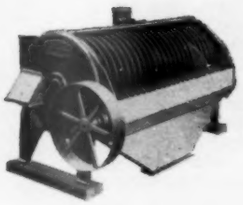

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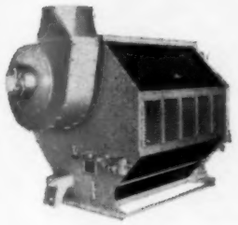

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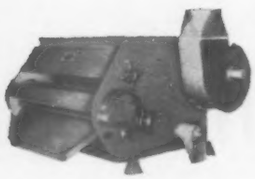

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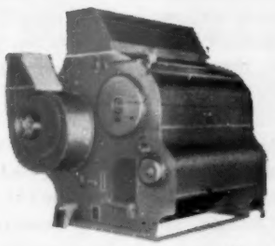

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